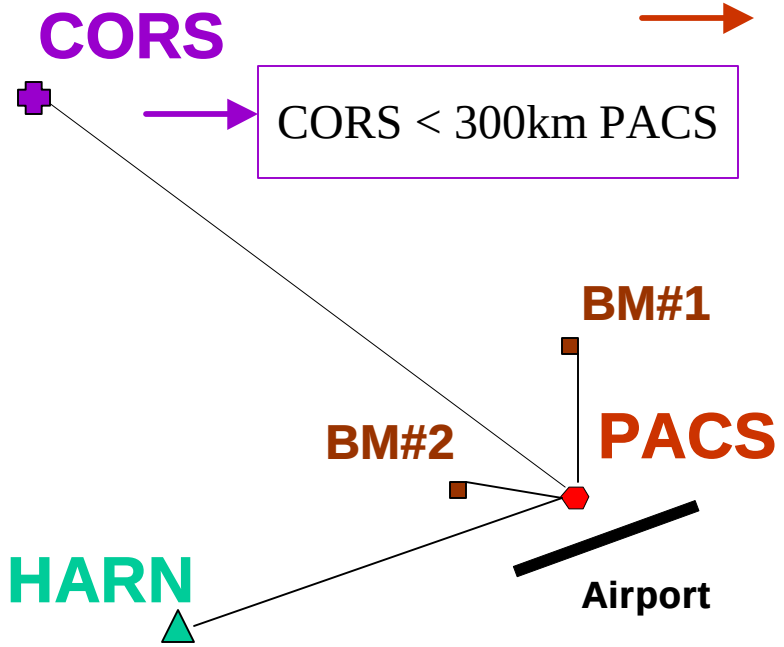
GPS Positioning Procedures

PACS Ties-

- **2, >4hr Sessions PACS - CORS**
- **1, >4hr Session PACS - HARN**
- **1, >4hr Session PACS - BM#1**
- **1, >4hr Session PACS - BM#2**



CORS < 300km PACS

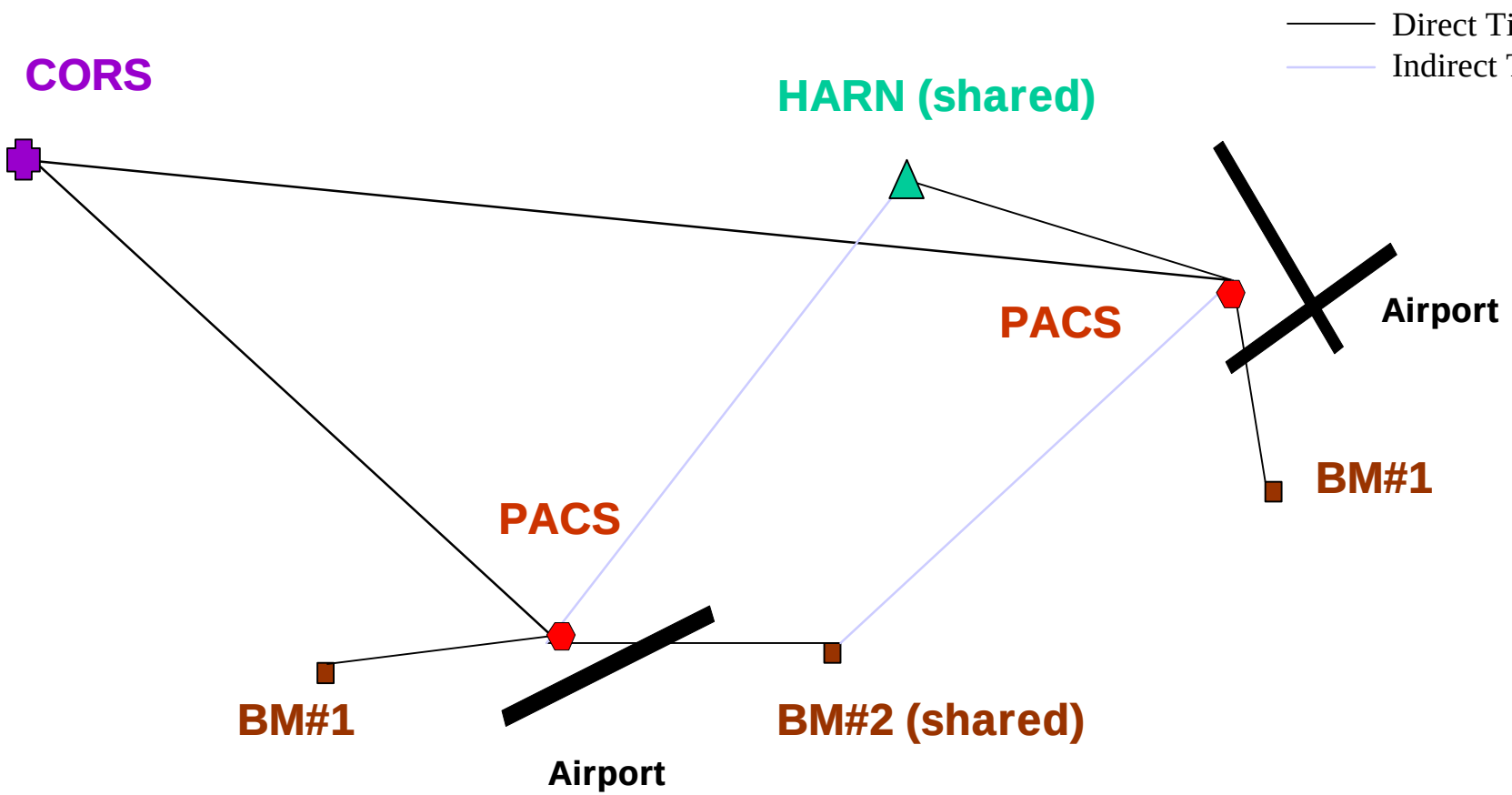
Bench Marks-
BM's > 1km Apart
BM's < 50km PACS

HARN > 50km CORS
HARN < 100km PACS

Simplified Schematic, See detailed requirements in the **General Specifications for Aeronautical Surveys, Vol. I, Establishment of Geodetic Control on Airports**
http://www.ngs.noaa.gov/AERO/aero.html

GPS Positioning Procedures

Shared HARN and BM ties- → Must be observed simultaneously with both PACS



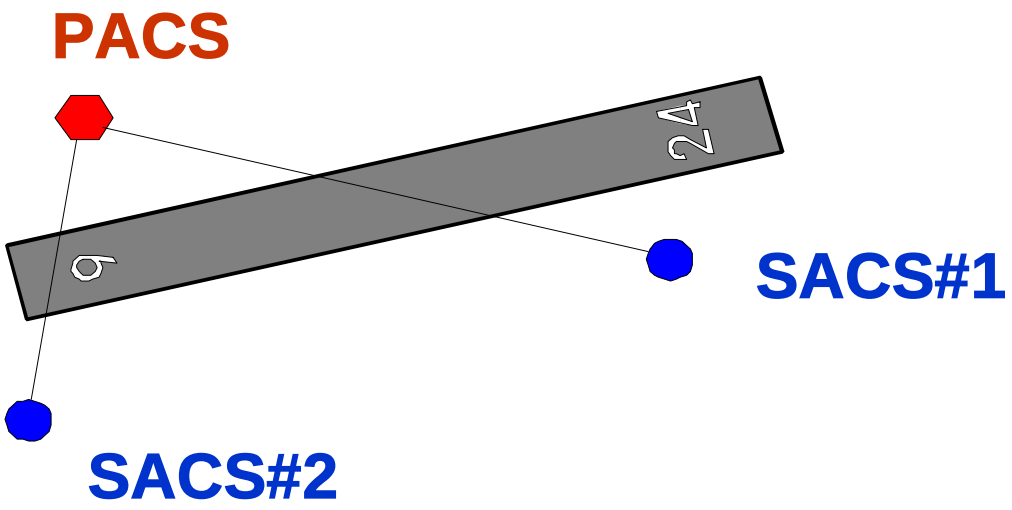
Simplified Schematic, See detailed requirements in the **General Specifications for Aeronautical Surveys, Vol. I, Establishment of Geodetic Control on Airports**
http://www.ngs.noaa.gov/AERO/aero.html

GPS Positioning Procedures

SACS Ties-

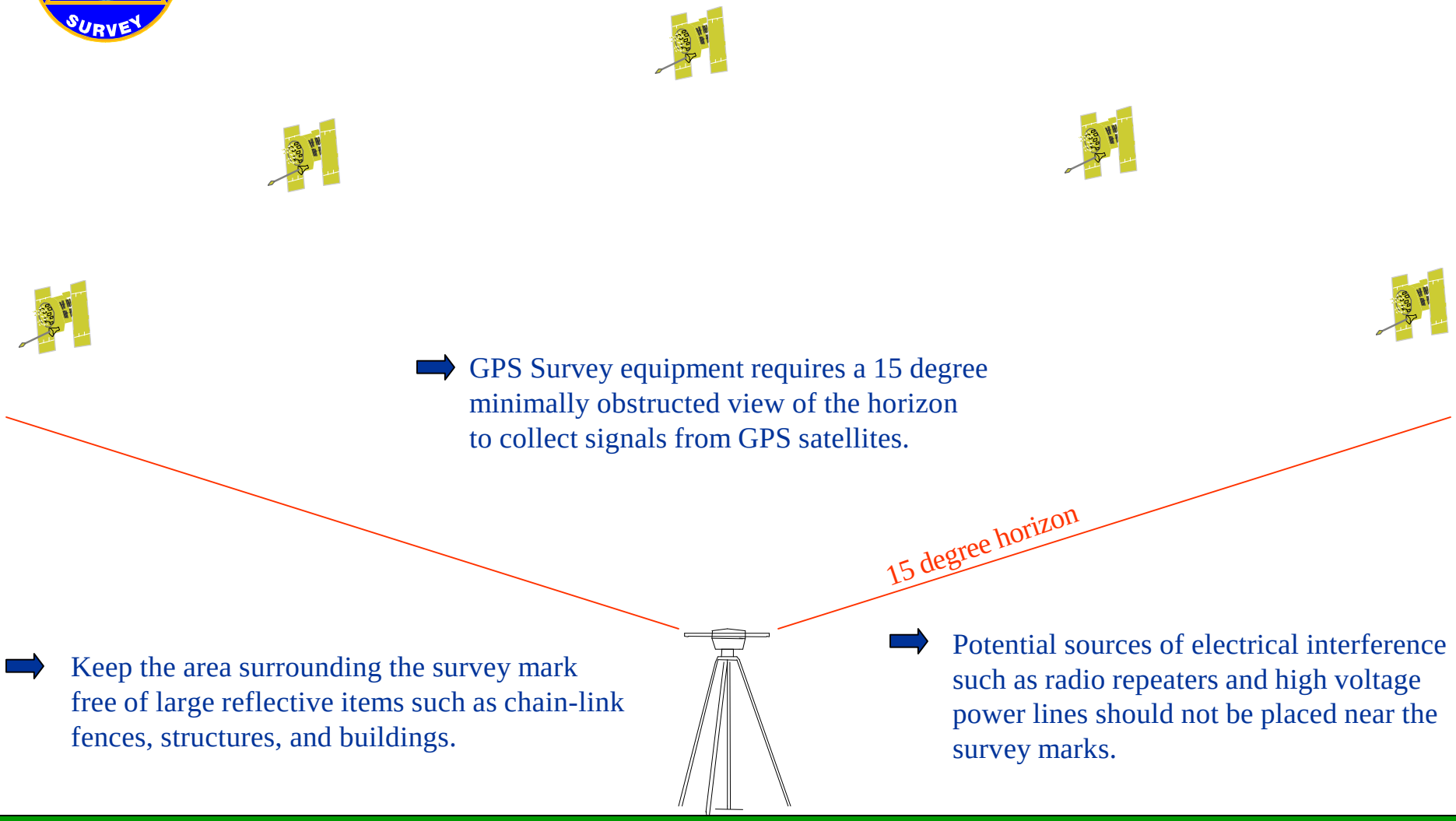
→ **2 >1.5 hr Sessions SACS - PACS**

→ **Separate Sessions by 2.5 Hours**



Simplified Schematic, See detailed requirements in the **General Specifications for Aeronautical Surveys, Vol. I, Establishment of Geodetic Control on Airports**
http://www.ngs.noaa.gov/AERO/aero.html

Protect the Airspace of ANA Geodetic Control Stations!



- GPS Survey equipment requires a 15 degree minimally obstructed view of the horizon to collect signals from GPS satellites.
- Keep the area surrounding the survey mark free of large reflective items such as chain-link fences, structures, and buildings.
- Potential sources of electrical interference such as radio repeaters and high voltage power lines should not be placed near the survey marks.

GPS Equipment set up over Survey Mark

National Oceanic and Atmospheric Administration

ANA Multi-Airport GPS Observation Scheme

Maine ANA Survey, 1998

AIRPORT(s)-Auburn-Lewiston Municipal Airport (LEW)
and Augusta State Airport (AFN)

Observation Day- Day 1, (045)
#Receivers Used- 6
CORS Tie- BRU1
A Order Tie- n/a
Observers- Contractor, Inc. (2); Subcontractor, Inc. (2)

(LEW)	(AFN)
PACS- LEW A Session 1- 8:00-13:30 (5.5hr) Session 2- 14:00-19:00 (5hr)	**PACS**- AUG AP STA C Session 1- 8:00-13:30 (5.5hr) Session 2- 14:00-19:00 (5hr)
SACS#1- LEW AP STA B Session 1- 8:00-10:30 (2.5hr) Session 2- 14:00-16:00 (2.0hr)	**SACS#1**- AUG AP STA B Session 1- 8:00-10:30 (2.5hr) Session 2- 14:00-16:00 (2.0hr)
SACS#2- ARP 1964 Session 1- 11:00-13:30 (2.5hr) Session 2- 16:30-19:00 (2.5hr)	**SACS#2**- AUG A Session 1- 11:00-13:30 (2.5hr) Session 2- 16:30-19:00 (2.5hr)
BM#1- E 171 8:00-13:00 (5hr)	**BM#1**- G 31 8:00-13:00 (5hr)
BM#2- G171 14:00-19:00 (5hr) **HARN**- A 196 14:00-19:00 (5hr)	

Remarks:
Session duration is fixed, start and end times are approximate depending on travel times, date of survey, satellite status, weather conditions, airport logistics etc. Stations used for multiple airports are listed on the center of the page.

Detailed station information is listed in the Station Table.

GPS STATION OBSERVATION LOG
(11-Nov-1999)

Station Designation: (FBN / CBN / PAC / SAC / BM)		Station PID:	Date (UTC):
General Location:	Airport ID, if any:	Station Four-Character ID:	Julian Day #:
Project Name:	Project Number: **GPS-**	Station Serial # (SSN):	Session ID: (A / B / C / D ...)

NAD83 Latitude o ‘ “	NAD83 Longitude o ‘ “	NAD83 Ellipsoidal Height meters NAVD88 Orthometric Ht. meters GEOID96 Geoid Height meters	Agency Full Name: Operator Full Name: Phone #: ( ) e-mail:

Planned Start Time (UTC) _____ Planned StopTime (UTC) _____ Epoch Interval = _____ Seconds
Actual Start Time (UTC) _____ Actual Stop Time (UTC) _____ Elevation Mask = _____ Degrees

GPS Receiver:
Manufacturer & Model:
P/N:
S/N:
Firmware Version:
” CamCorder Battery, ” 12V DC, ” 110V AC, ” Other

GPS Antenna:
Manufacturer & Model:
P/N:
S/N:
Cable Length, meters:
Vehicle is Parked _____ meters ____(direction) from antenna.

Antenna plumb before session?	(Y / N)	Circle yes or no -
Antenna plumb after session?	(Y / N)	If no, explain.
Antenna oriented to the North?	(Y / N)	“
Weather observed at antenna ht?	(Y / N)	“
Antenna ground plane used?	(Y / N)	“
Antenna radome used?	(Y / N)	If yes, describe
Eccentric occupation (>0.5 mm)?	(Y / N)	“
Any obstructions above 10°?	(Y / N)	Use visibility form
Radio interference source nearby?	(Y / N)	“

Tripod or Antenna Mount: Check one:
” Fixed-Height Tripod, ” Slip-Leg Tripod, ” Fixed Mount
Manufacturer & Model:
P/N:
S/N:
Last Calibration date:

Tribrach: Check one:
” None, ” Wild GDF 22, ” Topcon, ” Other (describe)
Last Calibration date:

** ANTENNA HEIGHT **
(see back of form for measurement illustration)

	Before Session Begins: measure and record both Meters	AND Feet	After Session Ends: measure and record both Meters	AND Feet
A= Datum point to Top of Tripod (Tripod Height)				
B= Top of Tripod to Antenna Ref. Point (Tribrach or Spacer)				
Q= Any Other Vertical Offsets? (Explain Below)				
H= Antenna Height **= A + B - Q** = Datum Point to Antenna Reference Point (ARP)				

Note: Meters = Feet X (0.3048)
Height Entered Into Receiver_____ meters
Please note and/or sketch **ANY** unusual conditions.
Be **Very Explicit** as to where and how Measured!

Barometer:
Manufacturer & Model:
P/N:
S/N:
Last Calibration or check Date:

Psychrometer:
Manufacturer & Model:
P/N:

Weather DATA	Time (UTC)	Dry-Bulb Temp Fahrenheit	Dry-Bulb Temp Celsius	Wet-Bulb Temp Fahrenheit	Wet-Bulb Temp Celsius	Rel. % Humidity	Atm. Pressure inches Hg	Atm. Pressure millibar	Weather Codes *
Before									
Middle									
After									
Average of Readings									* See back of form for codes

Remarks, Comments on Problems, Sketches, Pencil Rubbing, etc:

Note: Entries are Required in all Unshaded areas.

Data File Name(s):
(Standard NGS Format = aaaaddds.xxx)
where aaaa=4-Character ID, ddd=Julian day, s=Session ID, xxx=file dependant extension

Updated Station Description:	” Attached	” Submitted earlier
Visibility Obstruction Form:	” Attached	” Submitted earlier
Photographs of Station:	” Attached	” Submitted earlier
Pencil Rubbing of Mark:	” Attached	

LOG CHECKED BY:

ILLUSTRATION FOR ANTENNA HEIGHT MEASUREMENTS:

I. Instructions for Fixed-Height Tripods:

Measure & record the tripod length **(A)** and other offsets, if any, between the tripod and Antenna Reference Point (ARP) **(B)** and/or between the tripod and datum point **(Q)**.

$$Antenna\ Height = H = A + B - Q$$

II. Instructions for Slip-Leg Tripods:

NOTE: For Leica measuring hooks, use the instructions above.

1. Measure the Slant Height (S)

Before and after the observation session, measure the slope distance from the mark to at least three notches on the Bottom of Ground Plane (BGP) using two independent rulers (e.g., metric and Imperial). Record measurements in the table below, and compute the average.

Measure S	Notch #_	Notch #_	Notch #_	Average
Before, cm				
Before, inch				
After, cm				
After, inch				
Note: cm= inch x (2.54)		Overall average, cm		

S = _____ cm

2. Record the Antenna Radius (R) and the Antenna Constant (C)

The antenna radius is the horizontal distance from the Antenna Reference Point (ARP) to the measurement notch. The antenna constant is the vertical distance from the ARP to the BGP. See your Antenna specification manual for exact measurements.

R = _____ cm

C = _____ cm

3. Compute Antenna Height (H)

Use the following Pythagorean equation:

$$Antenna\ Height = H = ((\sqrt{S^2 - R^2}) - C) - Q$$

Record Antenna Height on the front of this form.

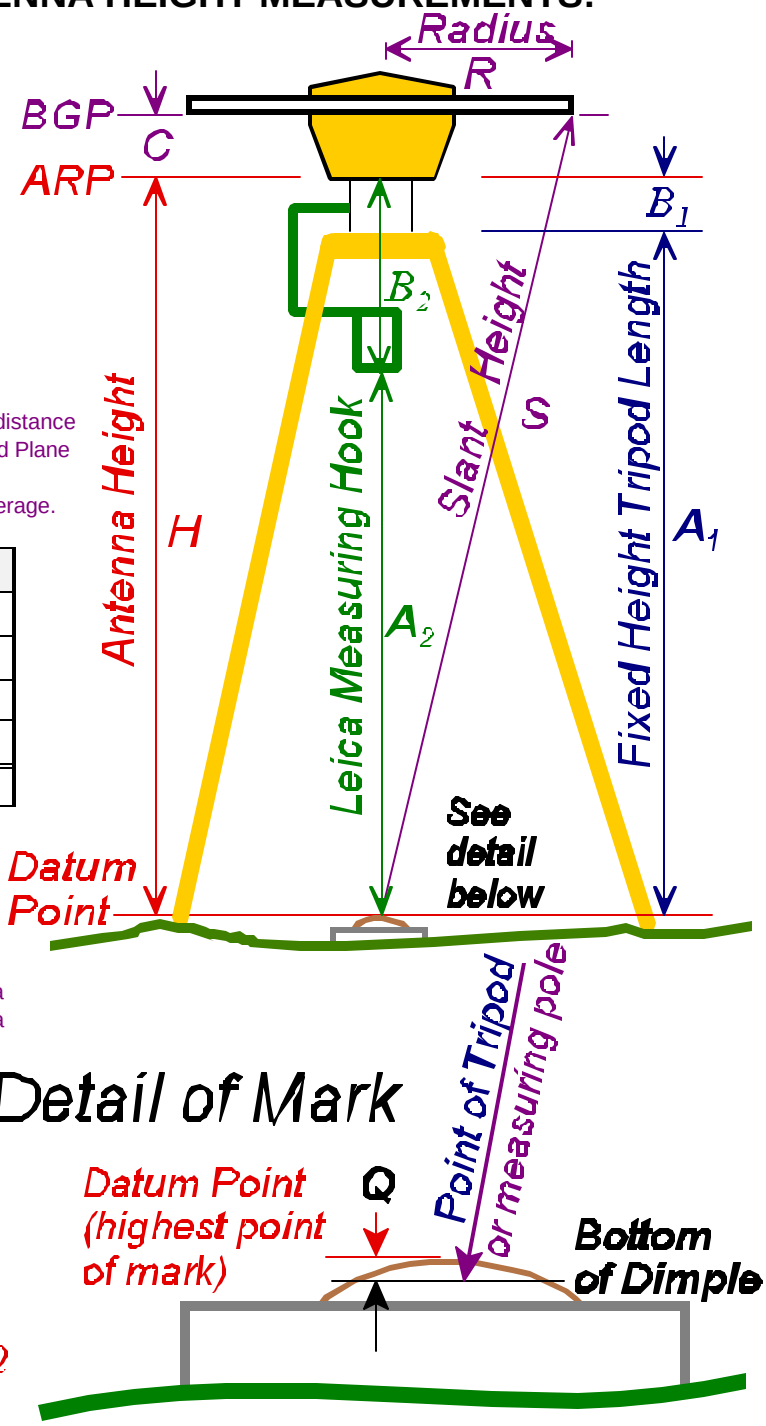


Table of Weather Codes -- for entry into Weather Data Table on front of form:					
CODE	PROBLEM	VISIBILITY	TEMPERATURE	CLOUD COVER	WIND
0	NO PROBLEMS encountered	GOOD More than 15 miles	NORMAL 32° F to 80°F	CLEAR Below 20%	CALM Under 5 mph (8 kph)
1	PROBLEMS encountered	FAIR 7 to 15 miles	HOT Over 80°F (27 C)	CLOUDY 20% to 70%	MODERATE 5 to 15 mph
2	-- NOT USED --	POOR Less than 7 miles	COLD Below 32° F (0 C)	OVERCAST Over 70%	STRONG over 15mph (24kph)
Examples: Code 00000 =	0 - No problems,	0 - good visibility,	0 - normal temperature,	0 - clear sky,	0 - calm wind
Code 12121 =	1 - Problems,	2 - poor visibility,	1 - hot temperature,	2 - overcast,	1 - moderate wind

Station Pencil Rubbing Form

Location / Airport Name
and ID_____ Project _____

Station Designation _____ PID_____ Date_____

Circle all applicable
PACS SACS BM FBN CBN OTHER_____

Observer &
Organization_____

Station Pencil Rubbing

Instructions: Place the blank form (or other blank paper) over the mark and rub over the entire disk with a pencil. For rod marks, rub only the designation and date stamping from the rim of the aluminum logo cap. If it is impossible to make a rubbing of the mark, or if the rubbing appears indistinct, a sketch and/or photograph may be substituted.

Remarks:

Monument Type_____

Inscribed Agency_____

Stamping_____

Attachment 14
GPS Antenna Height Measuring Instructions
(from the NGS GPS Survey Manual (draft))

Fixed height tripods are preferred over slip-leg tripods, as they reduce the potential for antenna height measurement errors. Use fixed height tripods whenever feasible. If a slip-leg tripod is used, a low tripod setup is preferred to minimize eccentricities, though the antenna should be set high enough to avoid obstructions. Eccentric setups (antenna out of plumb from the station datum point) are to be avoided. Note any eccentricities on the observation log.

Tripod legs should be well set and sandbagged or spiked to minimize movement.

Plumbing bubbles must be shaded for at least 3 minutes before use to minimize convective currents in the bubble fluid. On tripods with rotating center poles, the bubble must be rotated and checked level throughout a 180-degree arc.

Antennas should be oriented towards true north, as closely as can be accomplished with a hand compass. Note the magnetic declination in your local area to convert from magnetic north to true north.

The proper recordation of antenna height is critical. **The Antenna Height used at NGS is the vertical distance between the station datum point and the Antenna Reference Point (ARP)**. Observers must carefully measure and check this height, and record and describe all measurements and antenna constants. Record all values to 0.0001 meters or .001 foot. All measurement computations must be checked and initialed by another person.

Fixed-height tripods simplify the measurement of antenna height **(H)** [see diagram on last page of this attachment]. The calibrated tripod height **(A)** should be checked with a quick measurement. Ensure that the antenna mates securely with the tripod head, and that any gap **(B)** between the tripod head and ARP is measured and included. The antenna height can then be computed from the equation:

Antenna Height H= (A + B) - Q

NOTE: Leica antennas use a measuring hook to determine the vertical distance between the mark and antenna. Record the measured distance from the mark to the hook as A, and the offset from the hook to the ARP as B.

Slip-leg tripods antenna height **(H)** is usually measured by slant-height **(S),** the distance of the hypotenuse from the station datum point to the bottom edge of the antenna ground plane (BGP). Measure the slant height to at least 3 points around the antenna; these measurements should all agree to within 1 millimeter. Independent measurements of the antenna height above the mark in both metric and Imperial units must be made before and

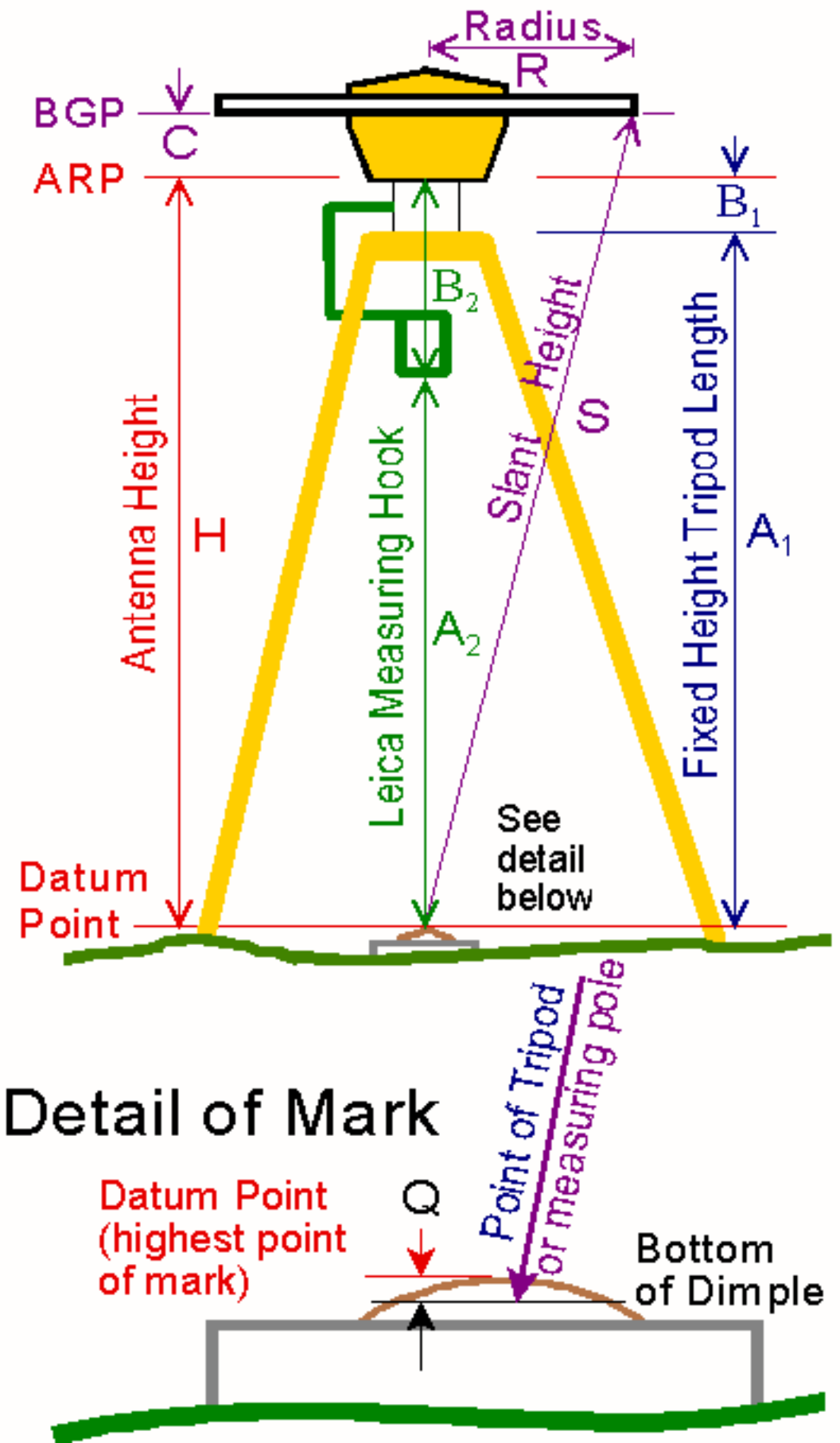
after each session. From the antenna specification sheet in your user's manual, determine the radius **(R)** of the ground plane and the offset constant **(C)** between the BGP and the ARP. The antenna height can then be computed from the following Pythagorean equation:

Antenna Height H= (sqrt(S 2 - R 2) - C) - Q

Compare Metric and Imperial measurements using the following equations:

Meters = Feet × (0.3048) Example: 1.286 Meters = 4.219 Feet
Feet = Meters ÷ (0.3048) Example: 5.345 Feet = 1.629 Meters

Note that the 3-dimensional datum point of a standard survey disk is located at or above the dimple in the disk's center, on a level with the highest point of the disk, where the foot of a level rod would rest. If the point of the fixed-height pole or slant-height measuring rod is recessed significantly below this level to reach the bottom of the dimple (1 millimeter or more), make a careful measurement of the vertical separation**(Q)** and note this on the observation log.


Radius
R
BGP
C
ARP
B1
B2
Antenna Height
H
Leica Measuring Hook
A2
Slant Height
S
Fixed Height Tripod Length
A1
See
detail
below
Datum
Point
Detail of Mark
Point of Tripod
or measuring pole
Datum Point
(highest point
of mark)
Q
Bottom
of Dimple